

## EVALUATION OF THE PHYTOTOXICITY OF COTTON MICRODUST COMPOST BASED ON SEED GERMINATION AND SEEDLING GROWTH

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### ABSTRACT

*This paper focuses on the experiment, to evaluate the phytotoxicity of five different composts obtained, by mixing inhalable cotton micro-dust, sugar cane bagasse and saw-dust in 1:1:1, 2:1:1, 3:1:1, 4:1:1 and 5:1:1 ratios and composted for 45 days. An experiment was carried out, to evaluate the affected of seed germination and seedling growth of *Trigonella foenum*, *Phaseolus vulgaris* and *Vigna radiata*, by aqueous extracts of compost. After incubation, germinated seeds were numbered (G) and root growth (L) was measured. Germination index (GI) was calculated:  $(GI) = G / G_0 \times L / L_0 \times 100$ , and values obtained using distilled water (control). Higher germination index, average root and shoot length was observed in compost Trail 3, prepared from substrate mixing in ratio of 3:1:1. Germination Index % of all trails were above 64 % and Trail 3 exhibited the highest GI% in 126 for *Trigonella foenum* seedling, 137 for *Phaseolus vulgaris* seedling and 101 for *Vigna radiata* seedling hence, were selected as best compost.*

**KEYWORDS:** Cotton Micro-Dust, Sugarcane Bagasse, Saw-Dust, Germination Index, Phytotoxicity & Physicochemical

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### INTRODUCTION

Phytotoxicity is one of the most important measures, to estimate the appropriateness of compost for agricultural function and to avoid environmental risks, before these composts can be used to agricultural field (Tiquia *et al.*, 1996; Brewer and Sullivan, 2003, Cooperband *et al.*, 2003, Adegunloye, 2009 & Farhan *et al.*, 2010). Many research works have reported that, using of immature compost into the soil causes negative effects on germination and growth development of the farm (Christian *et al.*, 1997). This side effect is because, the immature compost contain high microbial load, which reduce the concentration of oxygen in the soil and blocks the available nitrogen for plant uptake (Tiquia, 2003, Tuomela *et al.*, 2000, Zucconi *et al.*, 1981). Immature composts also containing compounds, such as heavy metals which are toxic to plant growth (Brewer, 2003, Tam and Tiquia, 1994, morel *et al.*, 1985, Mathur *et al.*, 1993 & Maggie *et al.*, 1967). Moreover, the presence of phenolic and ethylene compounds, ammonia, organic acids, and excess salts could retard seed germination and plant growth. Organic acid like Acetic acid is the most damaging acid, present in immature compost that mainly causes a phytotoxic effect (Ozores-Hampton, 1998). Application of no stabilized organic materials, will affect both the crops and environment (Bashan & Dubrovsky, 1996, Butler *et al.*, 2001). Phytotoxicity of compost is often evaluated, by seed germination or growth tests (Gariglio *et al.*, 2002 & Brewer and Sullivan, 2003), as presence of high concentrations of salt and the release of organic acids, is correlated with inhibition of seed germination and seed growth (Buswell, 1984).

The maturity of the compost can be studied by the germination index method, which is based on seed

germination and initial plant growth (Butler *et al.*, 2001, Cambardella *et al.*, 2003 & Carr 1995). This is done by using a liquid extract from the prepared compost. The compost is measured to be mature, when the germination index is higher than 60 % (Gajdos, 1997, Gariglio *et al.*, 2002 & Georgacakis *et al.*, 1996). In general, the compost is non-toxic, when the germination rate is more than 85% (Abdul *et al.*, 2013, Cheung and *et al.*, 1989). Composting is a practical approach for the sustainable reprocess of organic wastes (Finstein and miller, 1985, Tuomela *et al.*, 2000). Composting is a biological course of action, through which microbes alter organic materials into functional end products, which may be used as soil conditioners and/or organic fertilizers (Forstet *et al.*, 1993).

The particulate yield of composting, are extracted during the maturation and curing phase are called as compost. Composting has become a favored technique for municipalities and industries, to recycle a diversity of organic derivative into a safer and more stable material, for application to the soil (Butler *et al.*, 2001; Carr *et al.*, 1995). The waste material used for the composting varies in their nutrient and mineral substance, as this concern the rate of breakdown and the composition of developing compost (Adegunloye *et al.*, 2009).

## MATERIALS AND METHODS

### Sample Collection

Various composts were prepared using a combination of substrates; these substrates included sugar cane bagasse, saw dust, and blow room cotton micro dust from the textile industry. The effective microorganism solution was purchased from Environ Biotech.

### Sample Preparation

Approximately, 30- 31 Kg of substrate mixtures were prepared separately by mixing cotton micro dust, sugar cane bagasse and saw dust in 1:1:1, 2:1:1, 3:1:1, 4:1:1 and 5:1:1 ratios, respectively. Combinations of these substrates were properly mixed on a concrete platform with watering, to bring the final moisture in the range of 50- 62%. All the test composts were run in triplicate and the results were shown, with the average of three replicates.

### Sample Extraction

A water extract of compost were prepared, by shaking the samples with distilled water at 1:10 w/v ratio for 3 hours, and then filtered by filter paper.

### Seed Germination Experiment

The seeds of *Trigonella foenum*, *Phaseolus vulgaris* and *Vigna radiate* used in the study were first surface-sterilized with 0.1% mercuric chloride solution for 20 min, and washed properly with distilled water before germination to ensure viability. Thirty seeds of *Trigonella foenum*, *Phaseolus vulgaris* and *Vigna radiate* were placed in 9.5 cm Petri plates, lined with a double layer of Whatman No. 1 filter paper. Each plate was moistened with 5 ml of the respective extract concentrations. One plate is kept as a control, using distilled water. The Petri dishes were firmly sealed with parafilm and incubated for 6 days (124 hours) at  $27 \pm 2$  °C in a growth chamber (16 h light and 8 h dark). The initial seed germination count was done after 24 h of incubation, to determine percentage germination and/or inhibition. At the end of the 6-day growth was assessed, based on the lengths of plumule and radical relative to the control. Germination index (GI) was calculated:  $(GI) = G / G_0 \times L / L_0 \times 100$ , where  $(G_0)$  = No of seeds germinated in compost extract / No of seed germinated in control X 100 and  $(L_0)$  = mean root length in composts extract / mean root length in control X 100.

### Physicochemical Study of Selected Compost

The pH was determined on a suspension of sample in water (10 g/25 ml), the total nitrogen (Kjeldahl method). Phosphorus availability was determined by titration method, using quinoline and HCl. Phenolphthalein act as indicator. Organic matter present in the composite is also determined by the titration method.

## RESULTS

GI is mainly considered as a sensitive parameter, for identifying the phytotoxicity of compost. The suitability of compost for use as soil amendment, has also been calculated from these results. Many authors report that, root length contributes much to the results than shoot, as they are more sensitive to the toxins during germination, but it's a combination of relative germination and relative root elongation. (Emino *et al.*, 2004) Root and shoot lengths of 124 hr old three different seedlings (*Trigonella foenum*, *Phaseolus vulgaris* and *Vigna radiate*) in aqueous extracts of different substrates, are presented in Tables 1. The longest roots were observed in Trail 3, for *Trigonella foenum* and *Phaseolus vulgaris* i.e. 24.0 mm and 24.3 mm, respectively and Trail 2 for *Vigna radiate*. Meanwhile, extract of Trail 5 had an adverse effect on root length of all three seedlings i.e. 10.5mm, 10.9mm and 6.6 mm, respectively. The longest roots were observed in Trail 4, for *Trigonella foenum* *Phaseolus vulgaris* i.e. 37.0 mm, 37.3 mm, respectively and Trail 3 for *Vigna radiate*. Germination index was also calculated and given in table 2. While, observing GI %, out of five trails on substrate combination, three combinations showed >100 value on *Trigonella foenum* seeds, two combination showed >100 value on *Phaseolus vulgaris* seeds and three combinations showed >100 value, on *Vigna radiate* seeds.

**Table1: Seed Germination and Seedling Growth**

Samples	<i>Trigonella foenum</i>		<i>Phaseolus vulgaris</i>		<i>Vigna Radiate</i>	
	Average Root Length (cm)	Average Shoot Length (cm)	Average Root Length (cm)	Average Shoot Length (cm)	Average Root Length (cm)	Average Shoot Length (cm)
Control	17.7±0.624	3.7±0.624	18.0±0.153	3.8±0.513	16.4±0.451	2.7±0.513
Trail 1 (1:1:1)	16.3±0.611	2.7±0.557	16.5±0.306	2.7±0.603	14.1±0.100	2.9±0.551
Trail 2 (2:1:1)	14.2±0.058	3.0±0.666	14.3±0.321	3.1±0.764	24.3±0.577	2.4±0.436
Trail 3 (3:1:1)	24.0±0.000	2.6±0.872	24.3±0.577	2.6±1.012	19.8±0.681	3.6±0.513
Trail 4 (4:1:1)	19.5±0.500	3.7±0.808	19.9±0.854	3.7±0.874	10.7±1.955	4.9±0.551
Trail 5 (5:1:1)	10.5±1.572	4.7±1.044	10.9±2.178	4.9±1.210	6.6±0.764	4.0±0.436

**Table 2: Germination Index of Trails**

	Compost Samples	<i>Trigonella Foenum</i>	<i>Phaseolus Vulgaris</i>	<i>Vigna Radiate</i>
Germination Index %	Trail 1 (1:1:1)	64	80	101
	Trail 2 (2:1:1)	123	115	90
	Trail 3 (3:1:1)	126	137	101
	Trail 4 (4:1:1)	105	99	86
	Trail 5 (5:1:1)	92	91	156

All the parameters studied for selected compost (trail 3) in the work were studied, and the results are within specification by the Environmental Protection Agency, in accordance with Waste Licensing under the Waste Management Act 1996. The recommended range of moisture content was specified in Biotreat, 2003, and other constituents such as particle density, pH, conductivity, bulk density, available ammonia nitrogen, nitrate nitrogen, total phosphorus and potassium of compost in article of Bord na Mona, 2003 whereas, Limit for organic matter and C:N ratio calcium, magnesium and total nitrogen in compost as per Barker, 1997. The moisture content was 60 %. Particle size of compost

was 0.21456. pH at 25 °C (1% Suspension) was 6.10. The electrical conductivity (1% Suspension) of compost is 4.58 ds/m. The total nitrogen as N of the compost was 1.02 %. The phosphorous as P concentration was 698.84 mg/kg. Potassium as K concentration was 0.89 %. Organic matter content of the compost was 15.80 %. Magnesium as Mg concentration was 48.99 mg/kg. The sodium concentration was 0.023 %. The C/N ratio of all the compost was 18.1 %. The nitrate-nitrogen concentration varied from 145.8 mg/L.

## DISCUSSIONS

According to the obtained results of germination index, extract prepared for trail 3 (3:1:1) seems to be safer and clearly confirms that, complete composting reduce phytotoxicity, this was earlier proved in the results of Delgado *et al.*, 2010. Trail 3 (3:1:1) showed highest GI % on all three seeds and Trail 1 (1:1:1) showed minimum GI %. Results of Zucconi, 1985, indicated that, the GI value below 50 % indicates high phytotoxicity and 80% indicates no toxicity and when Index exceeds 100 % the compost is considered to be very good phytonutrient or phytostimulant, for the respective seedlings. Also, Ogbo *et al.*, 2010, Morel *et al.*, 1985, Mathur 1993, observed in their works that, root length were higher in maturing composts. Meanwhile, the pH value of selected compost was 6.10, which is pH raises, due to the organic acids breakdown, during the composting process that occurs during the decomposition, organic acid volatilization and discharge of ammonia by microbes, as they break down proteins and other organic nitrogen sources. The pH becomes neutral, as the ammonia is either evaporated or utilized by new microbial colony. Decreasing particle size will encourage microbial activity and clearly denote the rate of decomposition. The availability of carbon and nitrogen is increased in compost, by decreasing particle size. Fang and Wong, 1999 found a relationship between GI and C: N ratio and reported that, compost with good GI have soluble Carbon and Nitrogen for plant uptake. GI increases in supply of oxygen and indirectly proves that, compost was prepared by and matured under adequate temperature, oxygen, humidity and nutrient concentration. Wong *et al.*, 1983 and 1985, studied on various extracts of the same compost, at different percentages and noted that, GI percentage varies. Gariglio *et al.*, 2002 also concluded that GI did not increase at various compost extract, due to saw dust on *Salix* sp.

## CONCLUSIONS

Upcoming textile industries face great problems in waste management. Inhalable cotton dust wastes were selected, as the main raw material for composting as South India is rich in textile industry. As agriculture is the backbone of India, this research can give an economically viable product for farmers with cheap rate and high yield, without much soil and water pollution. The paper elaborates the phytotoxicity study of prepared compost, which gives improved quality of crops in agriculture. Germination study was also done, and results for parameters such as germination percentage, root length, shoot length, etc., and clearly denoted that, it can be used as biomanure without any restriction.

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